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Instructions for Forecasting Decay in Table Grapes for Storage

This report describes a method shippers can use in forecasting decay in grapes before storing them. The study on which the report is based is part of a program of research designed to achieve more efficient distribution of our farm products.

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INSTRUCTIONS FOR FORECASTING DECAY IN TABLE GRAPES FOR STORAGE

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Decay in stored table grapes could be reduced if, at harvest or shortly thereafter, the shipper could estimate the amount of decay that would develop in specific lots of fruit during storage. Such an estimate or forecast would enable him to arrange and identify his lots in storage in a way that would permit the marketing of poor keeping lots early and the retention of only sound, decay-free fruit for late marketing.

The storability of a particular lot of fruit may be judged from a history of fruit harvested in past years from the same vineyard, on the general appearance of the fruit at harvest, on the weather to which the fruit had been exposed before harvest, or on periodic inspections made during the storage period. A rating based on all but the last of these factors requires much experience and reliable storage records over a period of years. Such records may not be available in a new storage plant, in one in which the personnel are new, or in one storing fruit that may come from a different source each year. Neither can factors related to the effect of exposure to weather before harvest always be accurately evaluated. Heavy rains of long duration have a decisive effect on decay, but the effects of light rains of short duration, morning dews, and heavy fogs are more difficult to determine.

Forecasting decay in grapes for storage, using laboratory techniques, is a way of supplementing the available information about a particular lot of fruit and of arriving at a more objective prediction of its keeping quality.

MATERIALS AND METHODS

The method of forecasting is based on the fact that decay in stored grapes is caused primarily by infections that occur before harvest and that the customary fumigations with sulfur dioxide (SO_2)[1] kill only fungus spores on the surface of grapes and not the fungi that have entered the berries before harvest. Infections that occur in the vineyard may not have developed far enough by harvesttime to be detected, but the fungi causing these infections continue to grow during storage, resulting in the decay of individual berries despite fumigation. Measuring the incidence of such infections, therefore, provides a means of estimating the development of decay in storage.

<u>Equipment needed</u>.--Equipment and supplies needed to conduct the forecast under commercial conditions (fig. 1) are as follows:

Item 1. Pressure cooker, approximately 6-quart size, large enough to accommodate a basketful of test tubes.

Item 2. Test tubes, 1.5 cm. (about 5/8 inches) in diameter and 15 cm. (about 5-7/8 inches) in length with plugs made of absorbent cotton.

Item 3. Wire basket to hold test tubes in upright position.

Item 4. "Canned-gas" torch for flaming mouths of test tubes, if natural or bottled gas is not available.

[1] Ryall, A. L., and Harvey, J. M. The Cold Storage of Vinifera Table Grapes. U. S. Dept. Agr. Handbook 159, 46 pp., 1959.

Item 5. Bunsen burner for same use as item 4, if natural or bottled gas is available. A special petcock and rubber tubing is required to attach burner to gas line.

Item 6. Storage dish, 9 cm. (about 3-1/2 inches) in diameter and 7.5 cm. (about 3 inches) deep with cover. (Item 8 may be substituted for item 6.)

Item 7. Filter paper, to be placed in bottom of storage dish or jar. Paper toweling or blotter paper may also be used.

Item 8. Fruit jar, 1/2 pint, wide-mouth type. Lid should be spot-soldered to ring with gasket-side up. Jars should not be sealed during incubation period.

Item 9. Cellophane bags, 6 inches wide (plus gusset) and 12 inches long. (Not illustrated.) Do not use bags made of other types of film as they may interfere with the natural movement of atmospheric gases in and out of the jars.[2]

Item 10. Gas mask with canister for acid-type gases. (Not illustrated).

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Figure 1.--Equipment needed for forecast (see text for details).

Sterilizing the water.--Sterilize water before starting each forecasting test. It is convenient to have about 50 test tubes of sterile water, but the number will vary with the volume of samples being tested.

To sterilize the water, place 5 ml. (about 1-1/2 inches) of water in each test tube (item 2) and plug the top of the tube with absorbent cotton. The plug should extend about one inch into the tube, should fit snugly, and should flare out at the top so that it can be easily removed. Place the test tubes in a wire basket (item 3) and load into the pressure cooker (item 1). The cooker should have about 1 inch of water in it to provide steam for the sterilization. Close the cooker, place over a hot plate, and bring up to full pressure according to instructions given by the manufacturer of the pressure cooker. Hold pressure for 20 minutes; remove the cooker from the heat and allow it to cool. Cover the basketful of plugged tubes with a paper towel held in place with a rubber band to help prevent contamination of the water.

[2] The following types of cellophane are suitable for this test; Olin Matheson Co. LSAT, DuPont LSAD, American Viscose Co. MST, or others of equal quality.

Sampling. --The sample must be representative of the particular lot of grapes being tested. When the fruit is packed or lidded in the packinghouse the sample can be taken by clipping single berries from a large number of lugs as they pass along the conveyor toward the lidding machine (fig. 2). The size of the sample depends upon the size of the lot tested, but about 500 single berries per carload of grapes should suffice. The berries may be collected in a clean carton or lug box if desired, and later transferred to the incubation jars. However, a minimum of time should elapse between taking of the sample and running the forecast. The sample should be fumigated at the same time as the lot from which the sample was taken.

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Figure 2.--Collecting an individual berry sample from packed lug box of Emperor grapes.

Grapes packed and lidded in the field require a different method of sampling. Whole grape clusters or parts of clusters can be picked from a number of randomly situated vines in the vineyard. The sample should be taken from bunches located in various positions on the vine (high, low, inside, outside) so that the entire sample does not come from any one position. This composite field sample can then be taken to the packinghouse, and the single berries can be clipped from it for the forecasting test. Berries that would obviously be trimmed off and discarded in the packing operation should not be used for the test.

Samples of field-packed grapes may also be taken from the lugs as they are packed or lidded at a central location in the field, if this is compatible with the particular method of handling the fruit.

Placing sample in jar. --Place a filter paper or blotter (item 7) in the bottom of each jar (item 6 or 8) and add about 40 berries to each of them. A carload lot would thus require about 12 jars (480 berries). Always place the same number of berries in the jars as it simplifies calculating percentages when the sample is examined. Wash the jars thoroughly with soap and water between uses.

Fumigation. --Place the filled jars in a clean box, leaving them uncovered, but with lids leaning against the sides of the jars (fig. 3); the lids, jars, and fruit must all be fumigated with sulfur dioxide. The box should be fitted with a cloth cover that is folded back, leaving the box open, during fumigation, but that can be draped over the box when it is removed from the fumigation room. Place the box with samples in the fumigation room near the entrance door. Fumigate the room as usual with a 1-percent concentration of sulfur dioxide gas for 20 minutes or according to the particular fumigation method used. Before degassing (clearing) the room, turn off the fans, put on a gas mask, and enter the room; cover the jars with the lids and remove them from the room. The room can then be degassed as usual (turn fans back on, if desired).

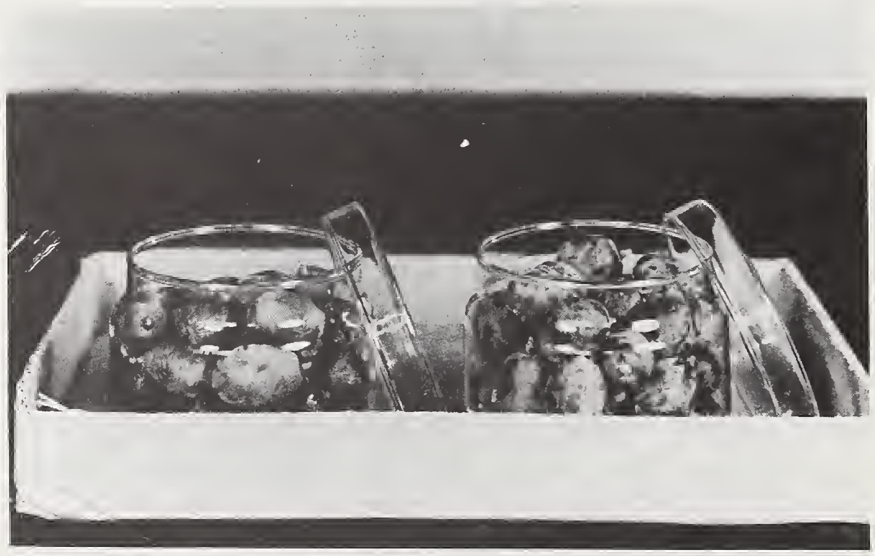

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Figure 3.--Position of incubation jars and lids during fumigation.

Another way to handle the box of samples is to cut a small door in the wall of the gassing room and build two small shelves, one on the inside and the other on the outside of the room. The shelves should be level with the bottom of the door to allow the box of samples to be slid into the room during gassing and slid out after gassing. When this arrangement is used, it is not necessary for the operator to go into the fumigation room. If it is not feasible to cut a hole in the wall of the gassing room, place the box of samples on a small dolly to which a rope is attached. Place the dolly inside the room near the doorway and pull it out at the end of the fumigation. Turn off the fans while the samples are being handled, and place the covers on the jars as soon as they are removed from the fumigation room.

Fumigation has killed the decay organisms on the surface of the berries, but has not killed the fungi (molds) that have already infected the fruit in the field. After fumigation, be careful to keep the sample sterile and to prevent outside contamination from spores drifting in the air, or carried by fruit flies, etc. Contamination would cause the development of types of decay during incubation that would not develop at low storage temperatures. A room in which there is little air movement is a good place to handle and hold the samples.

Humidifying. --Loosen the lids as much as possible without exposing the top of the jar, and allow the covered jars to stand one hour or overnight if the fruit is gassed late in the afternoon. The cloth cover should be draped over the box during this period. Allow

all the SO_2 gas to escape from the jars before they are humidified. Remove the cotton plug from a test tube and flame the lip of the tube (fig. 4) over a burner (item 4 or 5). The tube should not be heated too much or the glass will break when the water is poured out of the tube. When the tube is first placed in the flame, the glass will become clouded; as soon as it becomes clear again the right amount of heat has been applied. Pour the water into the jar after raising the lid slightly on one side (fig. 5) and re-cover. Save the cotton plugs since they may be reused.

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Figure 4.--Sterilizing the mouth of the test tube by flaming with a Bunsen burner.

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Figure 5.--Humidifying the incubation jar by adding sterile water.

The jar then acts as a moist chamber that favors the development of decay during the incubation period. As a further precaution against contamination cover the jars with cellophane bags--two jars fit in each bag (fig. 6). Do not use any material other than cellophane since certain films interfere with the normal movement of gases in the jar. The jars must not be sealed, and the lids should fit loosely at all times.

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Figure 6.--Cellophane bag placed over two jars during incubation to prevent contamination of the sample.

Incubation.--Ordinarily the samples should be held at room temperature (about 70° F.) for 10 days. However, if decay is likely to be severe, as it may be after rainfall, check the samples after 7 days and if a growth of mold is visible, examine them at that time.

Examination.--There are three types of decay that commonly occur in California storage grapes. These are gray mold (also called "slip skin" or Botrytis), Cladosporium rot, and Alternaria rot.[3] Gray mold rot (*Botrytis cinerea* Fr.) causes the skin to separate from the underlying tissues and when an infected berry is touched the skin slips away easily from the flesh. In the later stages of decay the whole berry is covered by a velvety, gray growth of mold.

Cladosporium rot (*Cladosporium herbarum* Fr.) is a black, rather firm type of decay that usually affects only a small portion of the berry, forming a rather sharp margin between the affected and sound tissue. In the moist incubation jar, an olive green growth of mold appears on the surface of affected areas. The color, the restricted growth, and the texture of the decay make it easy to distinguish Cladosporium from gray mold rot.

Alternaria rot (*Alternaria* and *Stemphylium* spp.) commonly develops in the area where the capstem is attached to the berry. Decay caused by this mold is rather soft in texture and brown in color; it may destroy the "brush," allowing the berry to drop from the cluster. Alternaria rot may also affect other portions of the berry, causing decayed areas that are not as firm, as dark in color, or as well defined as those caused by Cladosporium rot. Mold growth on the surface of such areas is white to olive green and is more fluffy in texture than the Cladosporium fungus.

When examining the berries after the incubation period, remove them one at a time from the incubation jar and roll each one between the thumb and forefinger to test for slip skin, which in its early stages may not be readily visible. Do not pour the berries out of the jar. This makes it difficult to determine if mold has spread from an infected berry to an adjacent one during the incubation period. Count only the original infected berry since the forecast is based on the measurement of field infections only.

The capstems will frequently have a fine weft of mold growing on them. This mold is usually Alternaria, but Cladosporium may also infect the capstems. Do not count such mold as decay, unless the adjacent portion of the berry has become affected.

[3] Types of decay are discussed further in "The Cold Storage of Vinifera Table Grapes." (See footnote 1.)

Berries in contact with the paper in the bottom of the jar sometimes crack and later become infected with mold that spreads from nearby capstems. Do not count decay from such sources. Remember that the forecast is based on the measurement of field infections, not infections that may have occurred during incubation.

Record the number of berries affected with each type of mold on a record sheet comparable to that shown in figure 7 and calculate the percentage of decay.

STORAGE DECAY FORECAST

Lot No. _______ Grower ______________________________ Soluble Solids ____________

Date of Harvest _________ Date Treated _______________ Date Examined ____________

Place of Storage ____ Room No. ________________

- -

		Berries affected by--		
Sample	Total berries	Gray mold	Cladosporium	Alternaria
1	______	______	______	______
2	______	______	______	______
3	______	______	______	______
4	______	______	______	______
5	______	______	______	______
6	______	______	______	______
7	______	______	______	______
8	______	______	______	______
9	______	______	______	______
10	______	______	______	______
11	______	______	______	______
12	______	______	______	______
Total	(a) ______	(b) ______	(c) ______	(d) ______

Percentage Gray Mold $\frac{(b)}{(a)}$ x 100 = ________ %[1]

Percentage Cladosporium $\frac{(c)}{(a)}$ x 100 = ________ %

Percentage Alternaria $\frac{(d)}{(a)}$ x 100 = ________ %

[1] Base forecast primarily on this figure.

Figure 7

INTERPRETATION OF RESULTS

Significance of decay types. --Gray mold rot is the most important type of storage decay: It develops more rapidly than the other types at storage temperatures; it tends to spread in storage, forming "nests" of decayed berries; it develops rapidly under moist conditions; and, therefore, it is most likely to spread widely, as illustrated in figure 8, and cause severe economic loss. Past experience with the forecast indicates that gray mold is more accurately forecast by laboratory techniques than the other two common types of storage decay. Rating fruit for decay, therefore, should be based primarily on the incidence of the gray mold rot indicated in the forecast.

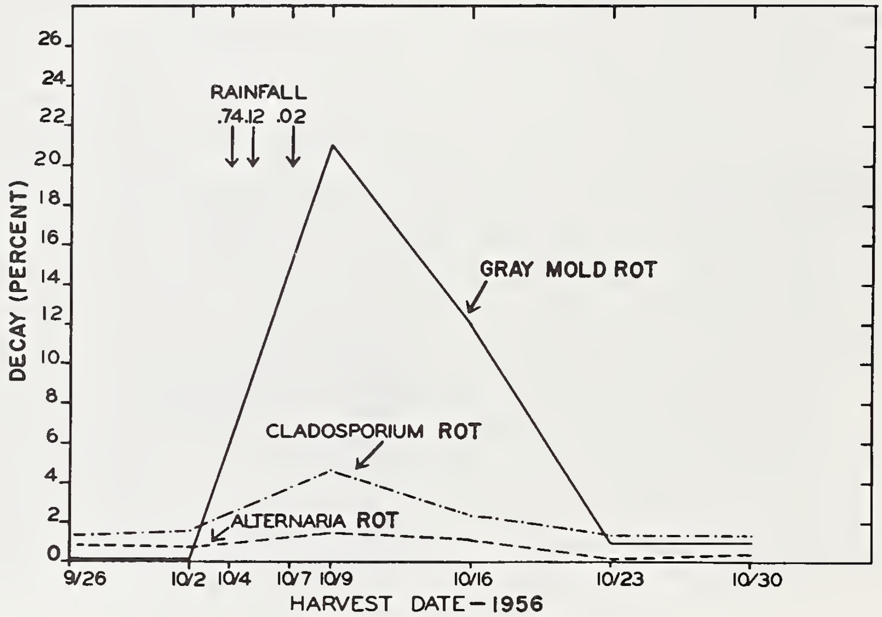

Figure 8.--Average percentages of various types of decay that developed after a 3-month storage period of Emperor grapes harvested from three vineyard plots at weekly intervals during the 1956 season.

Rating individual lots of grapes for storability. --The percentage of gray mold forecast for a given lot of fruit should not be taken as an absolute value, but as a relative value. Percentages of decay that may develop in storage will vary with the length of storage and the efficacy of the sulfur dioxide fumigations. If no secondary infections develop, the forecast and the actual decay in storage will not differ greatly (barring errors in sampling). But since gray mold does sometimes spread in storage, the decay indicated in individual lots in the forecast should be used only to rate the lots according to their relative storability.

Data on lots of grapes harvested in the 1956 season illustrate how the forecast can be used to advantage. The forecast of gray mold rot (fig. 9, A) indicated that it would be safe to store fruit harvested from plot I on all the dates indicated. Grapes from plots II and III, however, could be safely stored only if they were harvested between September 26 and October 2 (before rainfall) or between October 23 and 30.

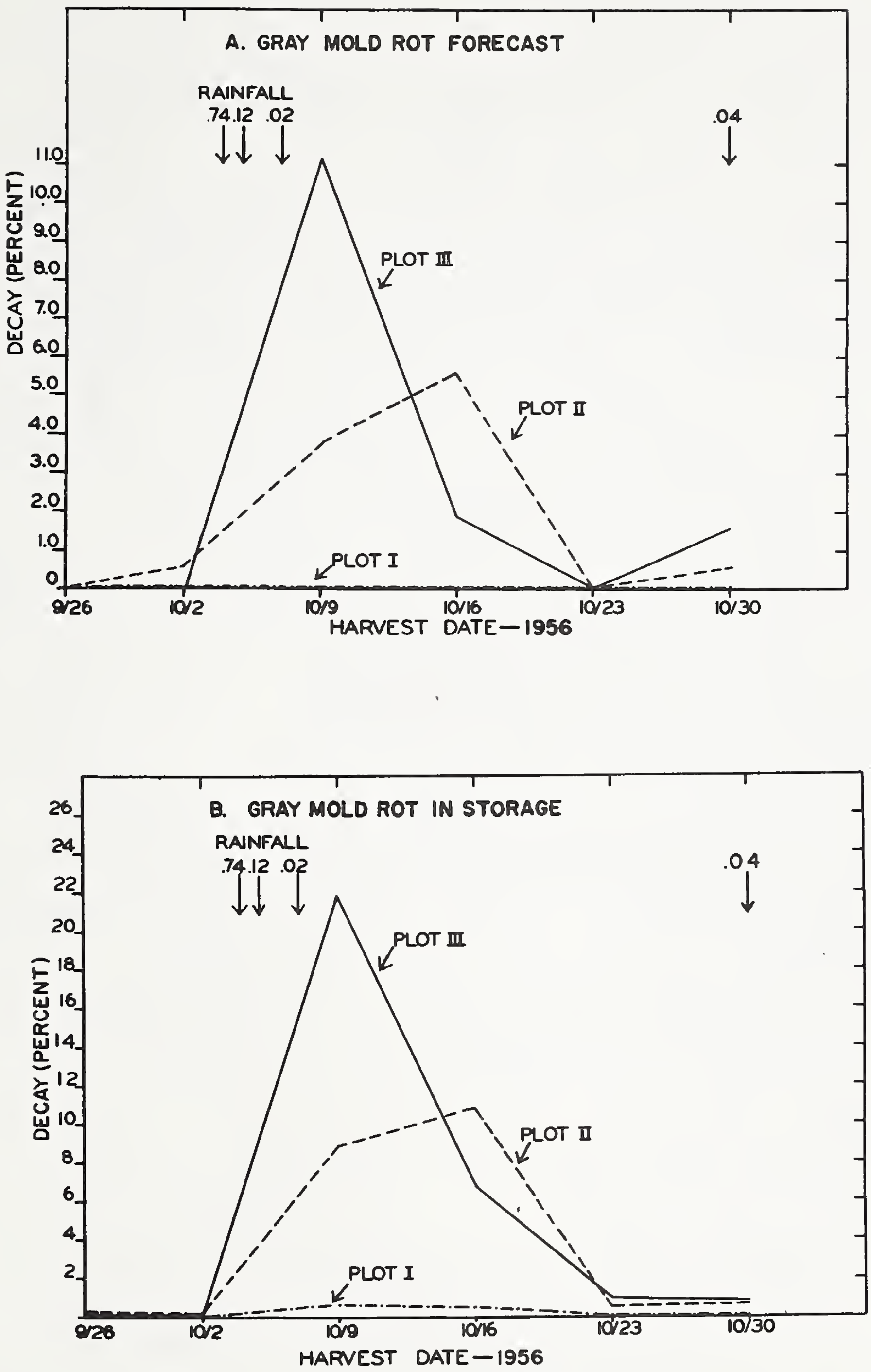

Figure 9.--Percentages of gray mold rot in Emperor grapes harvested from three plots at weekly intervals during the 1956 season. (A) Forecast; (B) after approximately 3 months in storage.

The percentage of gray mold rot that developed after 3 months' storage (fig. 9, B) indicated that the selection of storage lots based on the forecast was valid. Severity of decay in storage was greater than that indicated in the forecast, apparently due to spread of decay in storage, but this difference did not preclude a determination of the relative

degree of decay development in the individual storage lots. If the poor keeping lots had been marketed early and only the sound lots had been held in storage, the shipper's losses from decay would have been small.

Varieties in which gray mold can be forecast.--The forecast is most useful in varieties that are stored for relatively long periods, because the long storage time requires selectivity in the marketing of individual lots of fruit.

The forecast is primarily used for late-maturing varieties. Gray mold usually develops late in the season when the weather becomes cool and moist in California.

California varieties that have relatively long storage times and that mature late in the season are Emperor, Ribier, Almeria, Calmeria, and Tokay. Most of the experimental work has been done with Emperor, because this variety is the principal storage grape in California. The principles of forecasting decay, however, would apply to the other varieties mentioned.